The Fraser River is Getting Cleaner: Will it Continue to Improve?

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The Fraser River basin covers one quarter of British Columbia's area (fig.1) and is occupied by approximately 2.5 million people (more than half of its population). Six the province's pulp mills and many of its major cities (Prince George, Kamloops, Abbotsford, and Vancouver) discharge treated effluent into the river or its tributaries. The lower Fraser Valley, between the Coast Mountains and the Strait of Georgia, has the best agricultural land in the province that supports a highly developed farm economy, based on dairy, hog, poultry, berry crops and vegetables. Over the last 100 years these discharges and activities have resulted in pollution of many sections of the river. The federal government's Fraser River Action Plan was initiated to address this issue and to help communities develop a more sustainable relationship with the river. As part of that effort, Environment Canada undertook an assessment of the extent of contamination through a study involving several government-based groups and institutes, as well as university scientists. This abstract highlights some of the findings of the assessment and its implications for contamination levels in the future.

A major finding of the assessment was that levels of some contaminants in sediments, fish and wildlife have declined significantly over the last decade. This was particularly true for organochlorine compounds (OCs), including dioxins, furans, chlorophenols, PCBs, and organochlorine pesticides. For example, levels of tetrachlorinated dioxins and furans declined from 135 to 0.6 and from 1150 to 0.8 pg/g wet weight, respectively, in tissues from mountain whitefish collected downstream of Prince George between 1988 and 1994 (fig. 2). Although not as dramatic as the declines in whitefish, TEQs (Toxic Equivalent Units representing a suite of the most toxic PCBs, dioxins and furans) in osprey eggs collected downstream of Kamloops along the Thompson River declined from 65 to 15 ng TEQ/kg wet weight between 1991 and 1997. In both examples, the reason for the decline was the virtual elimination of chlorinated dioxin and furan discharges from pulp mills in response to consumer market demand for unbleached paper products and to new regulations under the Canadian Environmental Protection Act.

Declines in PCBs, chlorophenols, and organochlorine pesticides have not been as dramatic as those seen for dioxins and furans, because there was extensive use of these persistent chemicals during the 50s to 70s and there remain significant environmental "reservoirs" of these compounds even though their present use is banned or extremely limited. For example, there are still measurable quantities (parts per billion) of DDE in muscle and liver tissue in both peamouth chub and mountain whitefish throughout the basin (fig. 3). The highest levels are seen in fish collected in the river below Agassiz where agricultural and urban area soils are still releasing breakdown products of DDT used in the past.

In contrast to the OCs, levels of PAHs in sediments from the lower river areas have not decreased since the late 1980s and levels up to 200 ng/g wet weight in liver tissue were observed in peamouth chub collected from the estuarine river sections near Vancouver. Whether these levels are high enough to cause problems for fish populations is not known. The level of one PAH, for which human consumption guidelines exist, was at 50% of its guideline level.

While biochemical indicators of contaminant exposure, like chemical residues in tissues and MFO induction[1], were correlated with each other, indices of fish health impairment in mountain whitefish and peamouth chub were not correlated with contaminant levels in their tissues. This result suggests that stress due to contaminants is less than other stresses like high flows or temperatures, high suspended sediment concentrations, and parasitism which can all play a role in determining the health outcomes of fish populations in many sections of the river. However, whitefish and peamouth chub below industrial Prince George had discoloured livers or kidneys and lingcod in Kamloops Lake had a much higher liver-to-body weight ratio than lingcod from three other basin lakes not receiving industrial discharges. These latter observations suggest that these fish are experiencing some contaminant stress and that the stress could contribute to the cumulative stress affecting the health of these fish populations.

While the overall cleanup of contamination observed in the Fraser River is good news, it could be reversed in the upcoming decades because loadings of contaminants, like PAHs and metals in urban and agricultural runoff, are likely to increase with the rapidly expanding human population, especially in the lower Fraser Valley. There are two factors in urban landscapes that usually result in increases to these loadings; one is the tendency of urban development to make more of the land surface impervious and the other is the tendency for traffic densities to increase with population resulting in the deposition of more oil, PAH and metal per unit area of road or parking lot. This was clearly demonstrated in the Brunette River drainage basin (a tributary surrounded by Vancouver and Burnaby) where impervious area and traffic increased by 21% and 44%, respectively, between 1973 and 1993 (table 1) In agricultural areas, there has been a noticeable trend towards intensive farming techniques for raising dairy cattle, hogs, and poultry which has resulted in an enormous increase in manure disposal on farm land. This will lead to greater runoff of nutrients, metals (from feed supplements) and, potentially, some veterinary medicines like antibiotics or hormones.

Another process likely to limit further declines in OCs like PCBs, DDT, and toxaphene in fish and sediments is the annual release of these atmospherically deposited contaminants that accumulate on glaciers and snowfields every year. In addition, melting of the snow and ice layers storing the chemicals over the past 50 years may now be occurring. It has been postulated that climate warming in the last 10 years has accelerated the release of these stores of contaminants and decreased their annual net storage in glaciers. This process has not been evaluated quantitatively, but it has been invoked as a plausible explanation for the very high levels of these OCs (e.g. up to 3000 ng of PCBs /g wet weight) in lingcod liver tissue collected in Moose Lake near the headwaters of the Fraser in the Rocky Mountains. This section of the river receives mostly alpine runoff compared to samples collected in lower elevation lakes with much smaller or no amounts of alpine runoff. If this mechanism is occurring, it will cause low but ongoing loading of these chemicals to the river's headwaters. Subsequently, the chemicals will be adsorbed onto suspended sediments and accumulated in algae, zooplankton, benthos, fish, and predators of fish, such as otter or osprey.

In conclusion, the river's aquatic ecosystem is now exposed to relatively low levels of contaminants, which is attributable to better treatment of point source discharges and better management or banning of persistent chemicals. However, the combination of the continual low level contamination of the headwater streams in the Rocky Mountains and Coast Ranges with OCs derived from atmospheric deposition and the increasing loadings of PAHs and metals to smaller tributaries and the estuary from urban development and agricultural intensification will likely result in a gradual increase in levels for some of these chemicals. Increasing the effectiveness of nonpoint source controls in urban and farming areas may be required to keep concentrations of some contaminants from increasing.

The two volume summary report, entitled "Health of the Fraser River Aquatic Ecosystem: A Synthesis of Research Conducted under the Fraser River Action Plan" by C. Gray and T. Tuominen, containing much more detail on contaminant sources, transport, fate and effects as well as references is available on the web.

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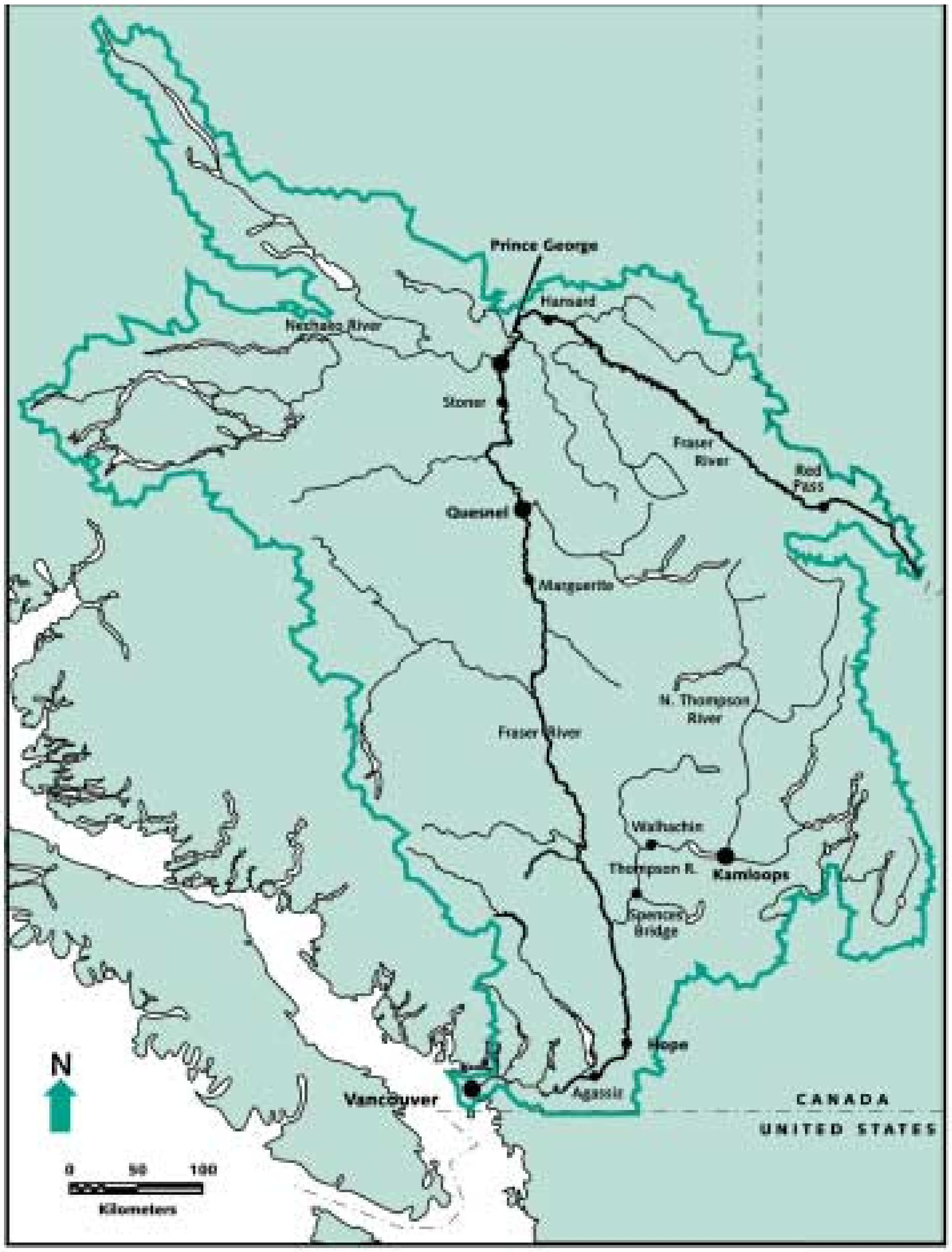
[1] Mixed function Oxidases (MFOs) are enzymes which liver cells produce to de-toxify contaminants. Unfortunately, some compounds cannot be de-toxifieds by these enzymes


Prince George
Hansard
Nechako River
Storner
Fraser
River
Red
Pass
Quesnel
Marguerite
N. Thompson
River
Fraser River
Walhachin
Thompson R.
Kamloops
Spences
Bridge
Hope
Agassiz
Vancouver
CANADA
UNITED STATES
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0
50
100
Kilometers

Figure 1

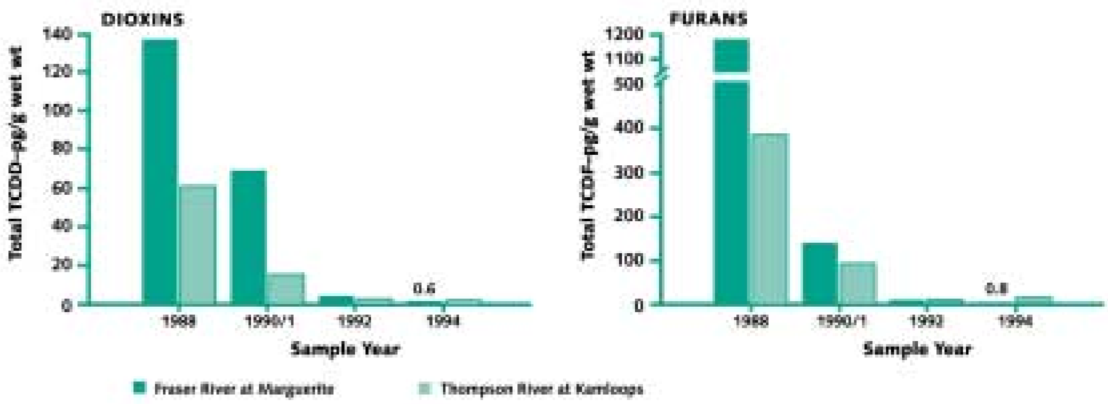

Figure 2

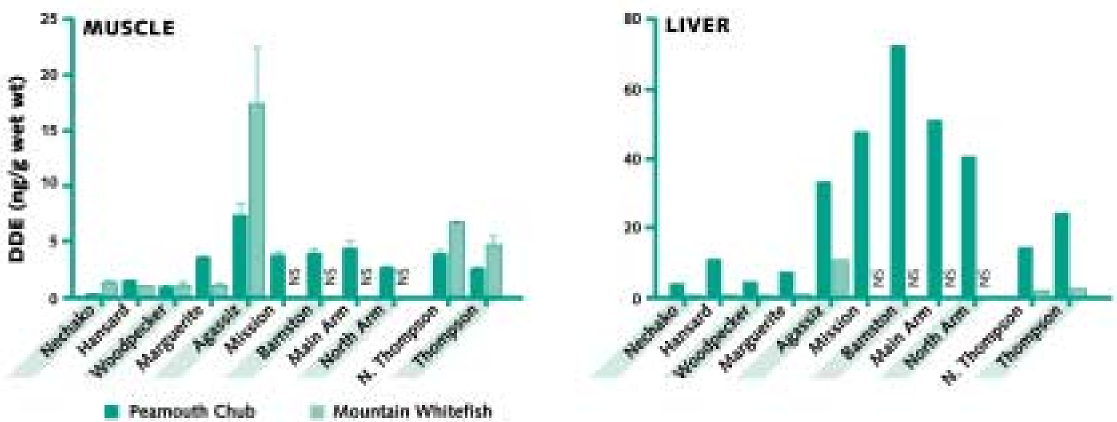

Figure 3

Changes in Brunette watershed land use and vehicular traffic between 1973 and 1993.

LAND USE / LAND COVER/ TRAFFIC	UNITS	1973	1993	% CHANGE
Residential	% of total area	40.8	45.7	+12
Industrial	% of total area	11.9	13.2	+11
Commercial	% of total area	3.6	4.1	+14
Institutional	% of total area	6.6	6.4	-3
Agricultural	% of total area	1.4	0	-100
Impervious area	% of total area	34	41	+21
Traffic density	million vehicle-km per day	3.0	4.3	+ 44

Figure 4